3.1.1 Kinematics

	Learning outcomes	Additional guidance
	Learners should be able to demonstrate and apply their knowledge and understanding of:	
(a)	displacement, instantaneous speed, average speed, velocity and acceleration	*M0.1, M1.4, M3.7, M3.9* HSW10, 12
(b)	graphical representations of displacement, speed, velocity and acceleration	*M3.6* HSW3 Using data-loggers to analyse motion.
(c)	Displacement–time graphs; velocity is gradient	*M3.4, M3.7*
(d)	Velocity–time graphs; acceleration is gradient; displacement is area under graph.	Learners will also be expected to estimate the area under non-linear graphs. *M3.5, M4.3*

(6) M - Compare displacement, distance, speed and velocity
(7) S - Calculate average and instantaneous speed
(8) C - Interpret distance and displacement time graphs

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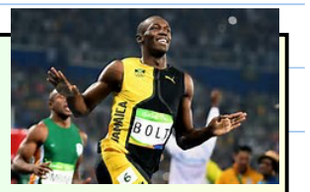
Lesson 1. Speed and velocity



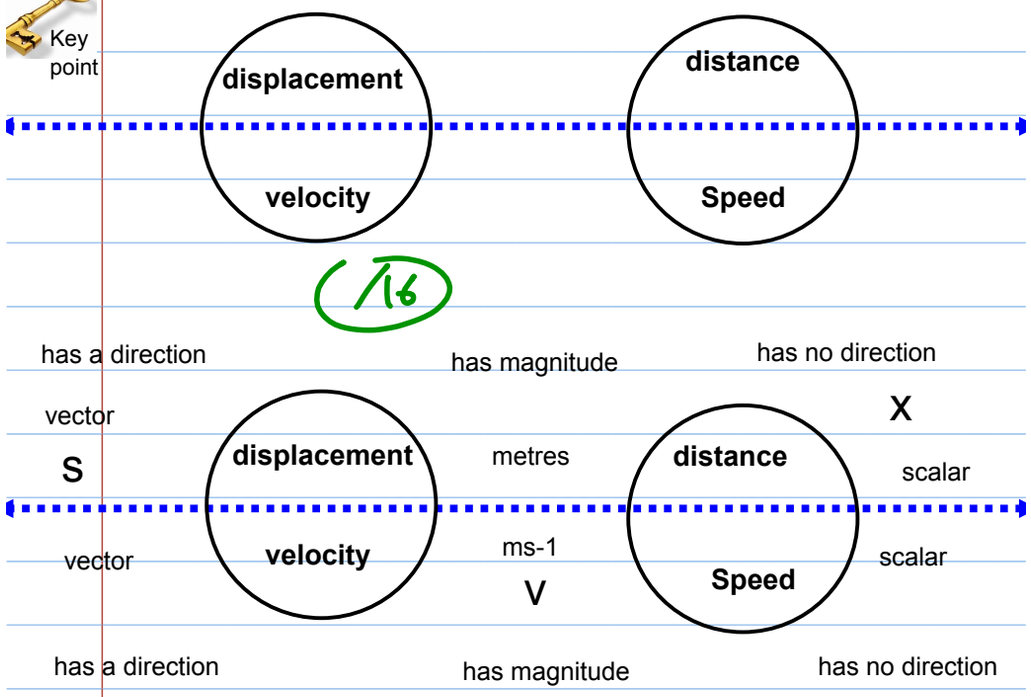
STARTER: Compare and contrast
- displacement and distance
- velocity and speed

HWK (due next lesson): Complete summary questions p26

Kilo 10^3
Mega 10^6
Giga 10^9

When is the speed of an object different from the velocity?

Key point



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Distance time graphs

ACTIVITY: Sketch these distance time graphs.

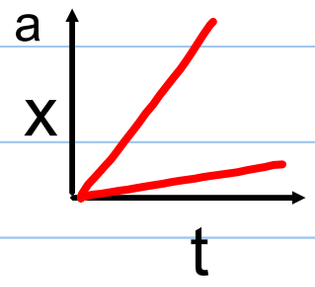
- a) constant speed (both high and low)
- b) accelerating
- c) decellerating
- d) stationary
- e) a ball thrown up in the air then coming back down

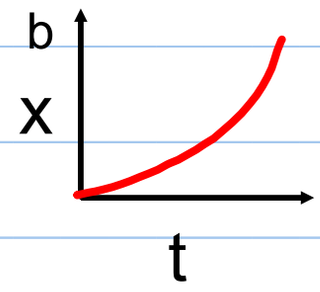
Kilo 10^3

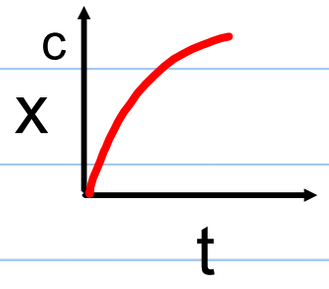
Mega 10^6

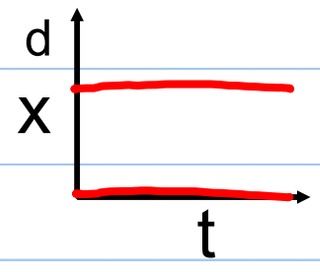
Giga 10^9

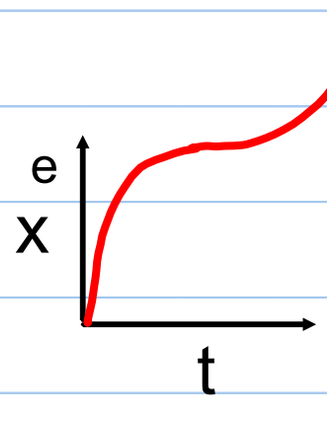
Ex: Explain why a distance time graph will always have a gradient value of zero or above.











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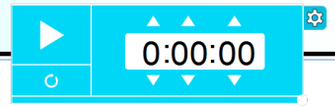


Calculating average speed

Key point

Average speed (v) is calculated from the distance travelled (x) and time taken (t).

$$\text{average speed} = \frac{\text{Total distance travelled}}{\text{time taken}}$$

$$\mathbf{v = \Delta x / \Delta t}$$

Bolt 2.20

Activity: Find bolts average speed from the clip.

Sketch a graph of x v t for bolts 100m

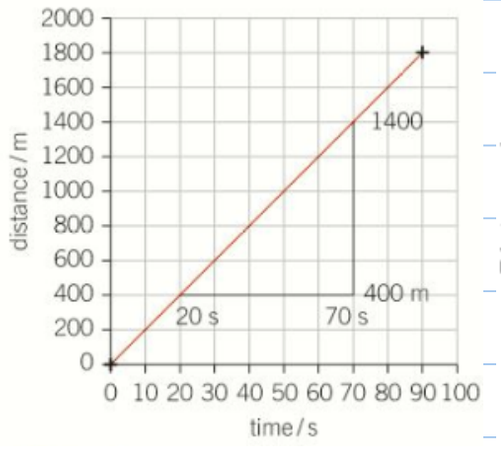
Calculating instantaneous speed

The instantaneous speed is the speed over a very short interval of time.

Calculated by drawing a tangent to the distance time graph at that time, then calculating the gradient.

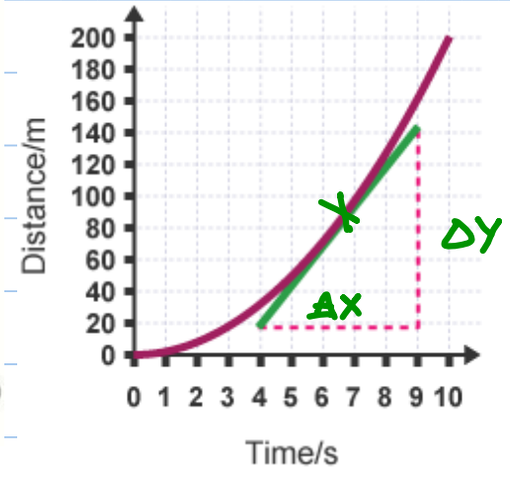
Instantaneous Speed = the gradient of a distance - time graph

Average = instantaneous speed



Gradient = Δy / Δx =

Varying speed over time



Gradient = Δy / Δx =

How can we find this gradient accurately?

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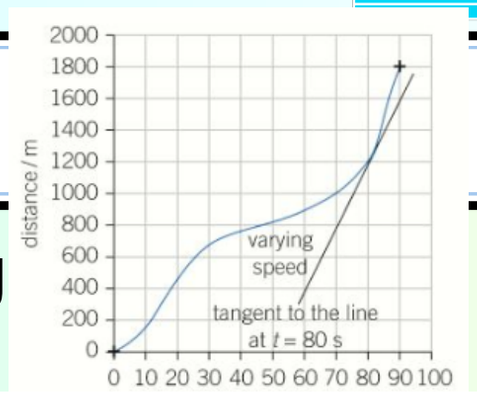

ACTIVITY: Try Q 5 and 6 on pag

Bolt's 100m races. Time elapsed /s every 10m*

Bolt	10	20	30	40	50	60	70	80	90	100
2008	1.83	2.87	3.78	4.65	5.5	6.32	7.14	7.96	8.79	9.69
2009	1.89	2.88	3.78	4.64	5.47	6.29	7.10	7.92	8.75	9.58

Olympic final, Beijing
World Champs, Berlin

Kilo 10^3

Mega 10^6

Giga 10^9

Ex: Find Usain bolts maximum speed.

compare this to his average speed.

Key point

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Average and instantaneous velocity.


Key point

$$\text{Average velocity} = \frac{\text{Change in displacement}}{\text{time taken}}$$

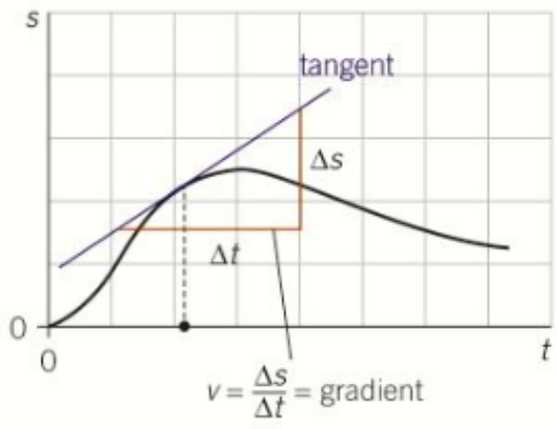
$$v = \frac{\Delta s}{\Delta t}$$

Ex: What can you say about the magnitude of the velocity of an object compared to the magnitude of the speed?

The magnitude of the **instantaneous** velocity is always **equal** to the magnitude of the **instantaneous** speed.

Average speed and **average** velocity can have **different** magnitudes.

Instantaneous velocity = Gradient of a displacement time graph.



▲ **Figure 4** *Velocity can be determined from the gradient of the displacement–time graph*

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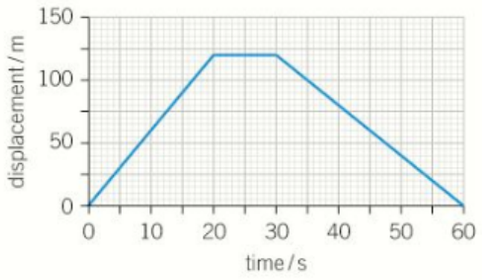
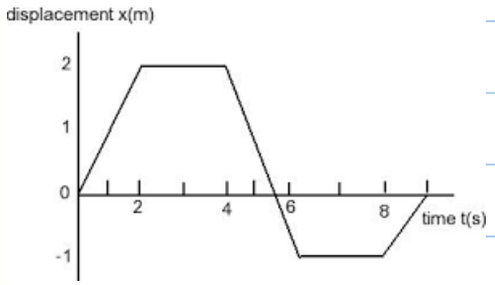
Displacement time graphs

Displacement time graphs **can have a negative gradient** as the object can decrease its overall displacement from the starting position.

The value of displacement can also go negative. What does this mean?



▲ **Figure 3** *A displacement–time graph for a car journey*

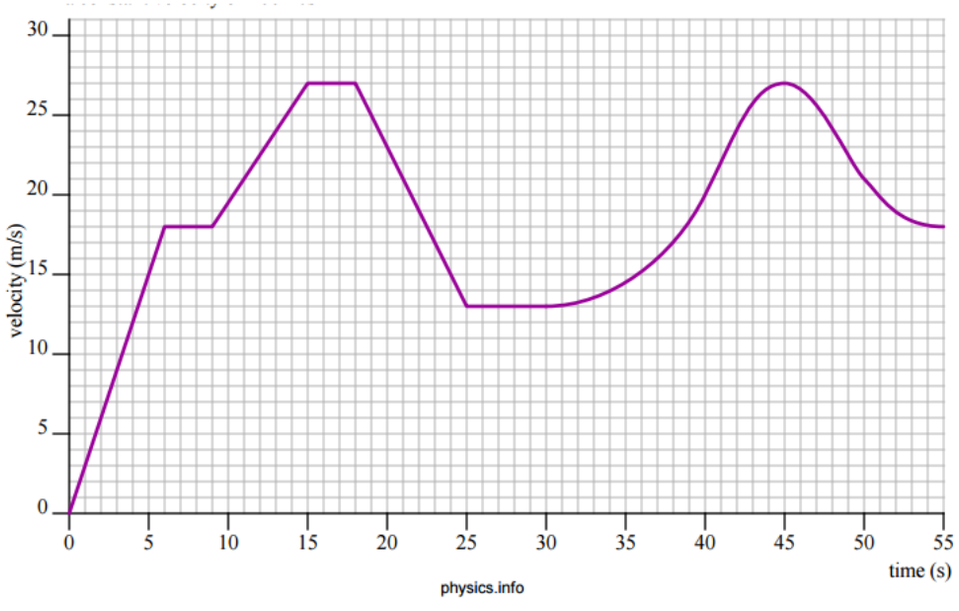


Key point

Discussion activity:

How many sections could you split this into to describe?

Describe the motion for each section



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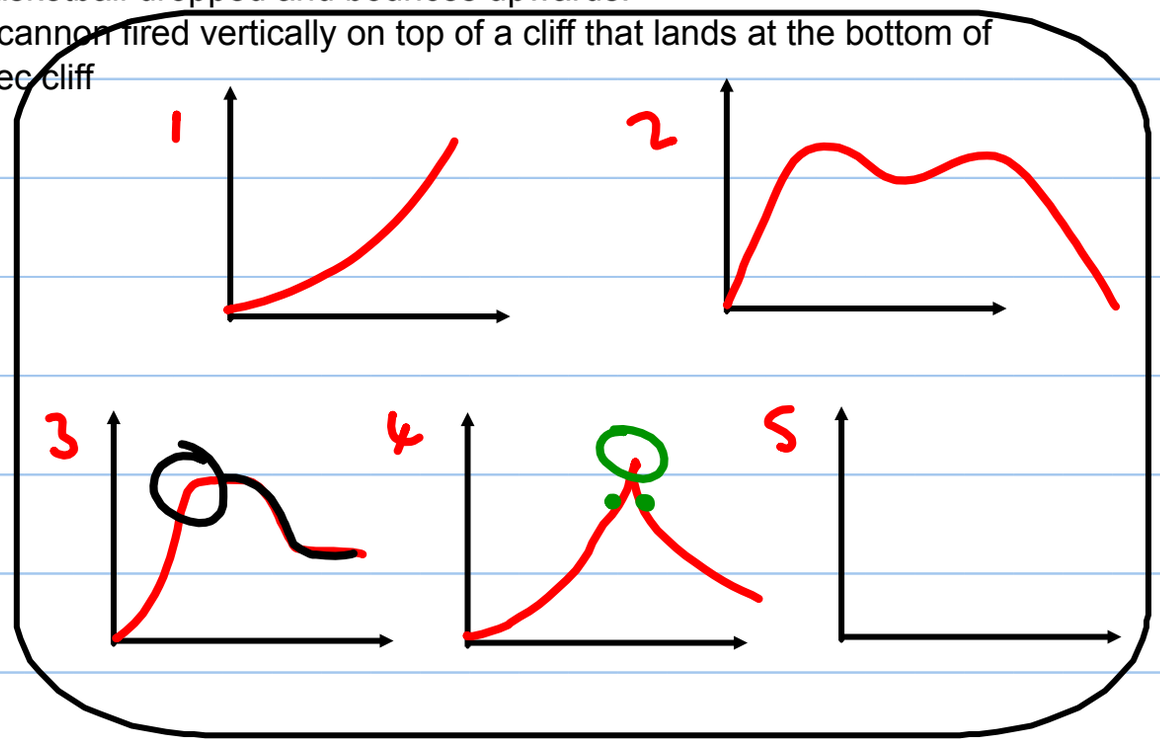
Displacement time graphs

Sketch these displacement time graphs:

1. Car accelerating from traffic lights.
2. Mo Farah completing his final lap of 5000m race
3. Elevator goes from lobby to 36th floor then back to 27th floor
4. Basketball dropped and bounces upwards.
5. A cannon fired vertically on top of a cliff that lands at the bottom of thec cliff

Key point



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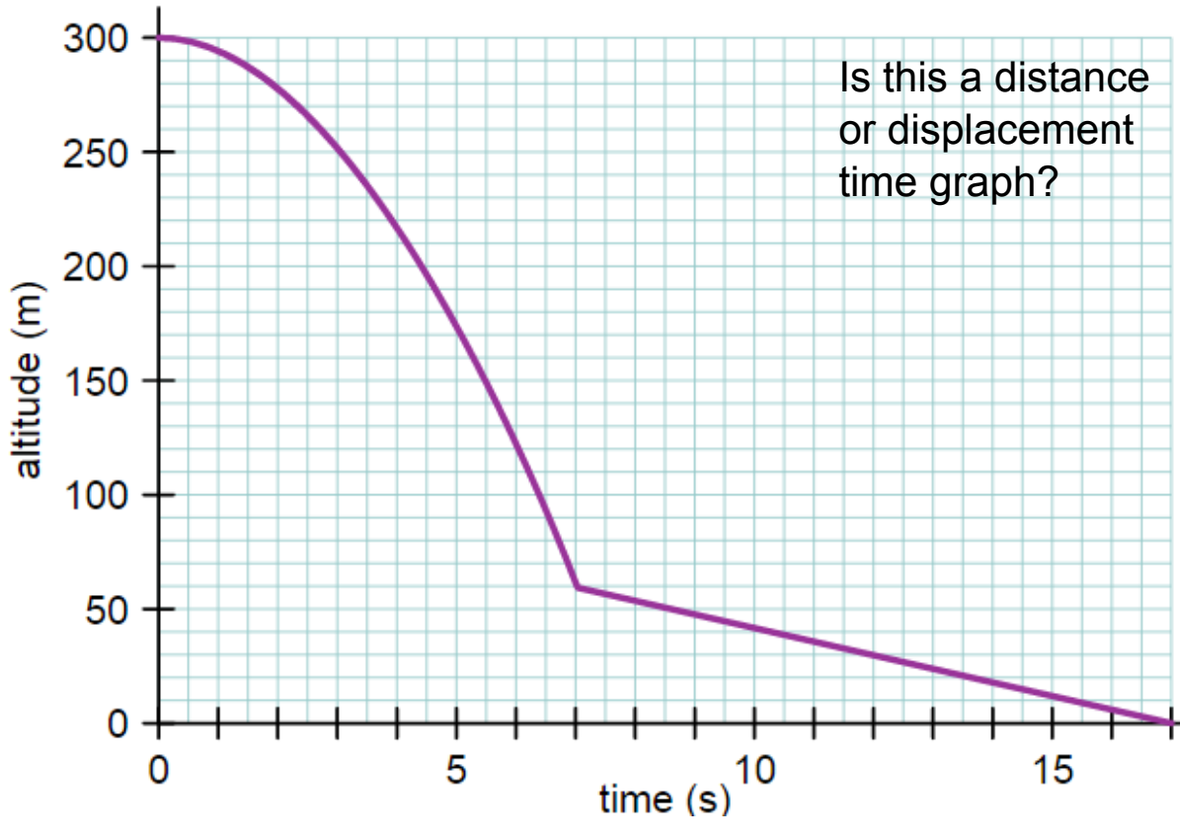
Plenary

What is the velocity of the skydiver:

1. At 2 seconds
2. Just before they open their parachute?
3. Describe and explain the motion of the skydiver...

Key point

a skydiver



Is this a distance or displacement time graph?